

Workgroup: I2NSF Working Group
Internet-Draft:
draft-jeong-i2nsf-security-management-
automation-04

Published: 25 July 2022

Intended Status: Informational

Expires: 26 January 2023

Authors: J. Jeong, Ed. P. Lingga
Sungkyunkwan University Sungkyunkwan University
J. Park D. Lopez S. Hares
ETRI Telefonica I+D Huawei

Security Management Automation of Cloud-Based Security Services in I2NSF Framework

Abstract

This document describes Security Management Automation (SMA) of cloud-based security services in the framework of Interface to Network Security Functions (I2NSF). The security management automation in this document deals with closed-loop security control, security policy translation, and security audit. To support these three features in SMA, this document specifies an augmented architecture of the I2NSF framework with new system components and new interfaces.

Status of This Memo

This Internet-Draft is submitted in full conformance with the provisions of BCP 78 and BCP 79.

Internet-Drafts are working documents of the Internet Engineering Task Force (IETF). Note that other groups may also distribute working documents as Internet-Drafts. The list of current Internet-Drafts is at <https://datatracker.ietf.org/drafts/current/>.

Internet-Drafts are draft documents valid for a maximum of six months and may be updated, replaced, or obsoleted by other documents at any time. It is inappropriate to use Internet-Drafts as reference material or to cite them other than as "work in progress."

This Internet-Draft will expire on 26 January 2023.

Copyright Notice

Copyright (c) 2022 IETF Trust and the persons identified as the document authors. All rights reserved.

This document is subject to BCP 78 and the IETF Trust's Legal Provisions Relating to IETF Documents

(<https://trustee.ietf.org/license-info>) in effect on the date of publication of this document. Please review these documents carefully, as they describe your rights and restrictions with respect to this document. Code Components extracted from this document must include Revised BSD License text as described in Section 4.e of the Trust Legal Provisions and are provided without warranty as described in the Revised BSD License.

Table of Contents

- [1. Introduction](#)
- [2. Terminology](#)
- [3. Security Management Automation in I2NSF Framework](#)
 - [3.1. Components with I2NSF Framework for Security Management Automation](#)
 - [3.2. Interfaces with SMA-Based I2NSF Framework](#)
- [4. Security Policy Translation](#)
- [5. Security Audit System](#)
- [6. IANA Considerations](#)
- [7. Security Considerations](#)
- [8. References](#)
 - [8.1. Normative References](#)
 - [8.2. Informative References](#)
- [Appendix A. Acknowledgments](#)
- [Appendix B. Contributors](#)
- [Appendix C. Changes from draft-jeong-i2nsf-security-management-automation-03](#)
- [Authors' Addresses](#)

1. Introduction

Interface to Network Security Functions (I2NSF) defines a framework and interfaces for interacting with Network Security Functions (NSFs) [[RFC8192](#)][[RFC8329](#)]. Note that an NSF is defined as software that provides a set of security-related services, such as (i) detecting unwanted activity, (ii) blocking or mitigating the effect of such unwanted activity in order to fulfill service requirements, and (iii) supporting communication stream integrity and confidentiality [[RFC8329](#)]. The NSF can be implemented as a Virtual Network Function (VNF) in a Network Functions Virtualization (NFV) environment [[ETSI-NFV](#)][[I-D.ietf-i2nsf-applicability](#)].

This document describes Security Management Automation (SMA) of cloud-based security services in the I2NSF framework. The security management automation includes closed-loop security control, security policy translation, and security audit. This document specifies an augmented architecture of the I2NSF framework for the SMA services with new system components and new interfaces.

For reliable management for networked security services, this document proposes a network management and verification facility using a security audit system (e.g., remote attestation and blockchain [[Bitcoin](#)]). This security audit system can facilitate the non-repudiation of configuration commands and monitoring data generated in the I2NSF framework.

Therefore, with the security service automation, this document facilitates the foundation of Intent-Based Networking (IBN) for autonomous security services [[I-D.irtf-nmrg-ibn-concepts-definitions](#)].

2. Terminology

This document uses the terminology described in [[RFC8329](#)] and [[I-D.ietf-i2nsf-applicability](#)]. In addition, the following terms are defined below:

*Security Management Automation (SMA): It means that a high-level security policy from a user (or administrator) is well-enforced in a target I2NSF system. The high-level security policy can be translated into the corresponding low-level security policy by a security policy translator and dispatched to appropriate NSFs. Through the monitoring of the NSFs, the activity and performance of the NSFs is monitored and analyzed. If needed, the security rules of the low-level security policy are augmented or new security rules are generated and configured to appropriate NSFs.

*Security Policy Translation (SPT): It means that a high-level security policy is translated to a low-level security policy that can be understood and configured by an NSF for a specific security service, such as firewall, web filter, deep packet inspection, DDoS-attack mitigation, and anti-virus.

*Feedback-Based Security Management (FSM): It means that a security service is evolved by updating a security policy (having security rules) and adding new security rules for detected security attacks by processing and analyzing the monitoring data of NSFs.

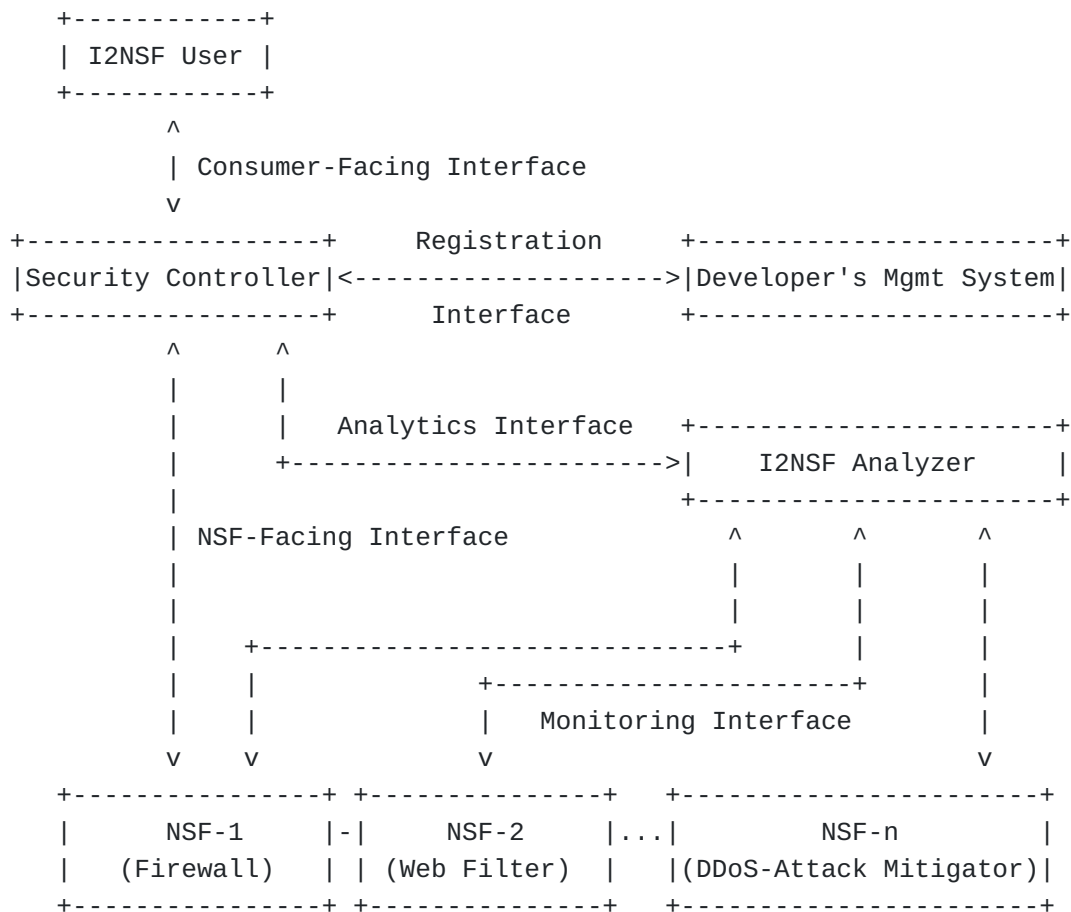


Figure 1: Security Management Automation in I2NSF Framework

3. Security Management Automation in I2NSF Framework

This section summarizes the I2NSF framework as defined in [RFC8329]. As shown in Figure 1, an I2NSF User can use security functions by delivering high-level security policies, which specify security requirements that the I2NSF user wants to enforce, to the Security Controller via the Consumer-Facing Interface (CFI) [I-D.ietf-i2nsf-consumer-facing-interface-dm].

3.1. Components with I2NSF Framework for Security Management Automation

The following are the system components for the SMA-based I2NSF framework.

*I2NSF User: An entity that delivers a high-level security policy to Security Controller.

*Security Controller: An entity that controls and manages other system components in the I2NSF framework. It translates a high-level security policy into the corresponding low-level security

policy and selects appropriate NSFs to execute the security rules of the low-level security policy.

*Developer's Management System (DMS): An entity that provides an image of a virtualized NSF for a security service to the I2NSF framework, and registers the capability and access information of an NSF with Security Controller.

*Network Security Function (NSF): An entity that is a Virtual Network Function (VNF) or Container Network Function (CNF), which is called Cloud-native Network Function, for a specific network security service such as firewall, web filter, deep packet inspection, DDoS-attack mitigation, and anti-virus.

*I2NSF Analyzer: An entity that collects monitoring data from NSFs and analyzes such data for checking the activity and performance of the NSFs using machine learning techniques (e.g., Deep Learning [[Deep-Learning](#)]). If there is a suspicious attack activity for the target network or NSF, I2NSF Analyzer delivers a report of the augmentation or generation of security rules to Security Controller.

For SMA-based security services with Feedback-Based Security Management (FSM), I2NSF Analyzer is required as a new I2NSF component for the legacy I2NSF framework [[RFC8329](#)] to collect monitoring data from NSFs and analyzing the monitoring data. The actual implementation of the analysis of monitoring data is out of the scope of this document.

3.2. Interfaces with SMA-Based I2NSF Framework

The following are the interfaces for the SMA-based I2NSF framework. Note that the interfaces are modeled with YANG [[RFC6020](#)] and security policies are delivered through either RESTCONF [[RFC8040](#)] or NETCONF [[RFC6241](#)].

*Consumer-Facing Interface: An interface between I2NSF User and Security Controller for the delivery of a high-level security policy [[I-D.ietf-i2nsf-consumer-facing-interface-dm](#)].

*NSF-Facing Interface: An interface between Security Controller and an NSF for the delivery of a low-level security policy [[I-D.ietf-i2nsf-nsf-facing-interface-dm](#)].

*Registration Interface: An interface between a DMS and Security Controller for the registration of an NSF's capability and access information with the Security Controller or the query of an NSF for a required low-level security policy [[I-D.ietf-i2nsf-registration-interface-dm](#)].

*Monitoring Interface: An interface between an NSF and I2NSF Analyzer for collecting monitoring data from an NSF to check the activity and performance of an NSF for a possible malicious traffic [[I-D.ietf-i2nsf-nsf-monitoring-data-model](#)].

*Analytics Interface: An interface between I2NSF Analyzer and Security Controller for the delivery of an analytics report of the augmentation or generation of security rules to Security Controller, which lets Security Controller apply the report for security rules to its security policy management.

For SMA-based security services with FSM, Analytics Interface is required as a new I2NSF interface for the legacy I2NSF framework [[RFC8329](#)] to deliver an analytics report of the augmentation or generation of security rules to Security Controller through the analysis of the monitoring data from NSFs.

4. Security Policy Translation

To facilitate Security Policy Translation (SPT), Security Controller needs to have a security policy translator that performs the translation of a high-level security policy into the corresponding low-level security policy. For the automatic SPT services, the I2NSF framework needs to bridge a high-level YANG data model and a low-level YANG data model in an automatic manner [[I-D.ietf-i2nsf-applicability](#)][[I-D.yang-i2nsf-security-policy-translation](#)]. Note that a high-level YANG data model is for the I2NSF Consumer-Facing Interface [[I-D.ietf-i2nsf-consumer-facing-interface-dm](#)], and a low-level YANG data model is for the I2NSF NSF-Facing Interface [[I-D.ietf-i2nsf-nsf-facing-interface-dm](#)].

[Figure 2](#) shows automatic mapping of high-level and low-level data models. Automatic Data Model Mapper takes a high-level YANG data module for the Consumer-Facing Interface and a low-level YANG data module for the NSF-Facing Interface. It then constructs a mapping table associating the data attributes (or variables) of the high-level YANG data module with the corresponding data attributes (or variables) of the low-level YANG data module. Also, it generates a set of production rules of the grammar for the construction of an XML file of low-level security policy rules.

[Figure 3](#) shows high-to-low security policy translation. A security policy translator is a component of Security Controller. The translator consists of three components such as Policy Data Model Mapper, Policy Data Extractor, Policy Data Converter, and Policy Generator.

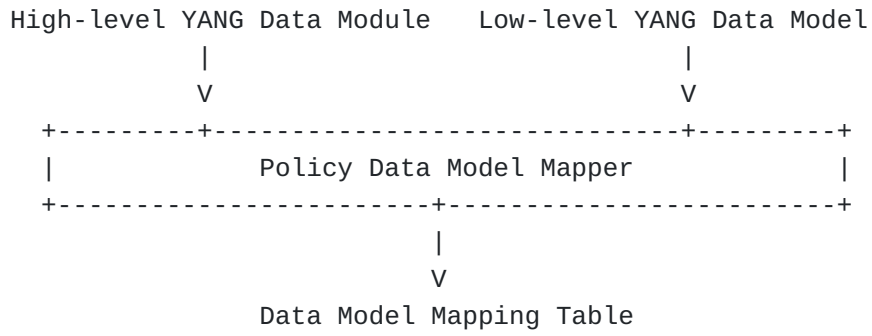


Figure 2: Automatic Mapping of High-level and Low-level Data Models

Policy Data Model Mapper maps the attributes and their values of a high-level security policy to the corresponding attributes and their values of a low-level security policy. Note that the values of a high-level security policy may involve a human language and must be converted to an appropriate value for a low-level security policy (e.g., employees -> 192.0.1.0/24).

Policy Data Extractor extracts the values of the attributes related to a security policy from a high-level security policy that was delivered by an I2NSF User to a Security Controller through the Consumer-Facing Interface [[I-D.ietf-i2nsf-consumer-facing-interface-dm](#)].

Policy Data Converter converts the values of the high-level policy's attributes into the values of the corresponding low-level policy's attributes to generate the low-level security policy [[I-D.ietf-i2nsf-nsf-facing-interface-dm](#)].

Policy Generator generates the corresponding low-level security policy that is delivered by the Security Controller to an appropriate NSF through NSF-Facing Interface [[I-D.ietf-i2nsf-nsf-facing-interface-dm](#)].

5. Security Audit System

The I2NSF framework is weak to both an insider attack and a supply chain attack since it trusts in NSFs provided by Developer's Management System (DMS) and assumes that NSFs work for their security services appropriately. [[I-D.ietf-i2nsf-applicability](#)].

To detect the malicious activity of either an insider attack by a malicious DMS or a supply chain attack by a compromised DMS, a security audit system is required by the I2NSF framework. This security audit system can facilitate the non-repudiation of configuration commands and monitoring data generated in the I2NSF framework.

A security audit system has the following four main objectives:

- *To check the existence of a security policy, a management system, and its procedures;
- *To identify and understand the existing vulnerabilities and risks of either an insider attack or a supply chain attack;
- *To review existing security controls on operational and administrative issues;
- *To provide recommendations and corrective actions to Security Controller for further security improvement.

6. IANA Considerations

This document does not require any IANA actions.

7. Security Considerations

The same security considerations for the I2NSF framework [RFC8329] are applicable to this document.

The development and introduction of I2NSF Analyzer and Security Audit System in the I2NSF Framework may create new security concerns that have to be anticipated at the design and specification time. The usage of machine learning to analyze monitoring data of malicious NSFs may add a risk to its model to be attacked (e.g., adversarial attack) and can result in a bad security policy that is deployed into the I2NSF system.

8. References

8.1. Normative References

- [RFC8192] Hares, S., Lopez, D., Zarny, M., Jacquenet, C., Kumar, R., and J. Jeong, "Interface to Network Security Functions (I2NSF): Problem Statement and Use Cases", RFC 8192, DOI 10.17487/RFC8192, July 2017, <<https://www.rfc-editor.org/info/rfc8192>>.
- [RFC8329] Lopez, D., Lopez, E., Dunbar, L., Strassner, J., and R. Kumar, "Framework for Interface to Network Security Functions", DOI 10.17487/RFC8329, RFC 8329, February 2018, <<https://www.rfc-editor.org/info/rfc8329>>.
- [RFC6020] Bjorklund, M., Ed., "YANG - A Data Modeling Language for the Network Configuration Protocol (NETCONF)", RFC 6020, DOI 10.17487/RFC6020, October 2010, <<https://www.rfc-editor.org/info/rfc6020>>.
- [RFC8040] Bierman, A., Bjorklund, M., and K. Watsen, "RESTCONF Protocol", DOI 10.17487/RFC8040, RFC 8040, January 2017, <<https://www.rfc-editor.org/info/rfc8040>>.
- [RFC6241] Enns, R., Ed., Bjorklund, M., Ed., Schoenwaelder, J., Ed., and A. Bierman, Ed., "Network Configuration Protocol (NETCONF)", DOI 10.17487/RFC6241, RFC 6241, June 2011, <<https://www.rfc-editor.org/info/rfc6241>>.
- [I-D.ietf-i2nsf-consumer-facing-interface-dm] Jeong, J. P., Chung, C., Ahn, T., Kumar, R., and S. Hares, "I2NSF Consumer-Facing Interface YANG Data Model", Work in Progress, Internet-Draft, draft-ietf-i2nsf-consumer-

facing-interface-dm-21, June 2022, <<https://www.ietf.org/archive/id/draft-ietf-i2nsf-consumer-facing-interface-dm-21.txt>>.

[I-D.ietf-i2nsf-nsf-facing-interface-dm] Kim, J. T., Jeong, J. P., Park, J., Hares, S., and Q. Lin, "I2NSF Network Security Function-Facing Interface YANG Data Model", Work in Progress, Internet-Draft, draft-ietf-i2nsf-nsf-facing-interface-dm-29, June 2022, <<https://www.ietf.org/archive/id/draft-ietf-i2nsf-nsf-facing-interface-dm-29.txt>>.

[I-D.ietf-i2nsf-registration-interface-dm] Hyun, S., Jeong, J. P., Roh, T., Wi, S., and J. Park, "I2NSF Registration Interface YANG Data Model", Work in Progress, Internet-Draft, draft-ietf-i2nsf-registration-interface-dm-18, 16 June 2022, <<https://www.ietf.org/archive/id/draft-ietf-i2nsf-registration-interface-dm-18.txt>>.

[I-D.ietf-i2nsf-nsf-monitoring-data-model]

Jeong, J. P., Lingga, P., Hares, S., Xia, L. F., and H. Birkholz, "I2NSF NSF Monitoring Interface YANG Data Model", Work in Progress, Internet-Draft, draft-ietf-i2nsf-nsf-monitoring-data-model-20, June 2022, <<https://www.ietf.org/archive/id/draft-ietf-i2nsf-nsf-monitoring-data-model-20.txt>>.

8.2. Informative References

[I-D.ietf-i2nsf-applicability] Jeong, J. P., Hyun, S., Ahn, T., Hares, S., and D. R. Lopez, "Applicability of Interfaces to Network Security Functions to Network-Based Security Services", Work in Progress, Internet-Draft, draft-ietf-i2nsf-applicability-18, 16 September 2019, <<https://www.ietf.org/archive/id/draft-ietf-i2nsf-applicability-18.txt>>.

[I-D.irtf-nmrg-ibn-concepts-definitions]

Clemm, A., Ciavaglia, L., Granville, L. Z., and J. Tantsura, "Intent-Based Networking - Concepts and Definitions", Work in Progress, Internet-Draft, draft-irtf-nmrg-ibn-concepts-definitions-09, 24 March 2022, <<https://www.ietf.org/archive/id/draft-irtf-nmrg-ibn-concepts-definitions-09.txt>>.

[I-D.yang-i2nsf-security-policy-translation] Jeong, J. P., Lingga, P., Yang, J., and J. Kim, "Guidelines for Security Policy Translation in Interface to Network Security Functions", Work in Progress, Internet-Draft, draft-yang-i2nsf-security-policy-translation-11, 28 April 2022, <<https://>

www.ietf.org/archive/id/draft-yang-i2nsf-security-policy-translation-11.txt>.

[I-D.ietf-rats-architecture] Birkholz, H., Thaler, D., Richardson, M., Smith, N., and W. Pan, "Remote Attestation Procedures Architecture", Work in Progress, Internet-Draft, draft-ietf-rats-architecture-19, 24 July 2022, <<https://datatracker.ietf.org/api/v1/doc/document/draft-ietf-rats-architecture/>>.

[I-D.yang-i2nsf-remote-attestation-interface-dm]

Yang, P., Chen, M., Su, L., Lopiz, D., Jeong, J. P., and L. Dunbar, "I2NSF Remote Attestation Interface YANG Data Model", Work in Progress, Internet-Draft, draft-yang-i2nsf-remote-attestation-interface-dm-01, June 2022, <<https://www.ietf.org/archive/id/draft-yang-i2nsf-remote-attestation-interface-dm-01.txt>>.

[ETSI-NFV] "Network Functions Virtualisation (NFV); Architectural Framework", Available: https://www.etsi.org/deliver/etsi_gs/nfv/001_099/002/01.01.01_60/gs_nfv002v010101p.pdf, October 2013.

[Bitcoin] Nakamoto, S., "Bitcoin: A Peer-to-Peer Electronic Cash System", URL: <https://bitcoin.org/bitcoin.pdf>, May 2009.

[Deep-Learning] Goodfellow, I., Bengio, Y., and A. Courville, "Deep Learning", Publisher: The MIT Press, URL: <https://www.deeplearningbook.org/>, November 2016.

Appendix A. Acknowledgments

This work was supported in part by Institute of Information & Communications Technology Planning & Evaluation (IITP) grant funded by the Korea Ministry of Science and ICT (MSIT) (2020-0-00395-003, Standard Development of Blockchain based Network Management Automation Technology). This work was supported by the IITP grant funded by the Korea MSIT (R-20160222-002755, Cloud based Security Intelligence Technology Development for the Customized Security Service Provisioning).

Appendix B. Contributors

This document is made by the group effort of I2NSF working group. Many people actively contributed to this document, such as Linda Dunbar, Yoav Nir, and Qin Wu. The authors sincerely appreciate their contributions.

The following are co-authors of this document:

Jeonghyeon Kim - Department of Electrical and Computer Engineering,
Sungkyunkwan University, 2066 Seobu-ro Jangan-gu, Suwon, Gyeonggi-do
16419, Republic of Korea. EMail: jeonghyeon12@skku.edu

Yunchul Choi - Electronics and Telecommunications Research Institute,
218 Gajeong-Ro, Yuseong-Gu, Daejeon, 34129, Republic of Korea. EMail:
cyc79@etri.re.kr

Younghan Kim - School of Electronic Engineering, Soongsil University,
369, Sangdo-ro, Dongjak-gu, Seoul 06978, Republic of Korea. EMail:
younghak@ssu.ac.kr

Appendix C. Changes from draft-jeong-i2nsf-security-management-automation-03

The following changes are made from draft-jeong-i2nsf-security-management-automation-03:

*This version replaces "Application Interface" with "Analytics Interface" to deliver analytics information from I2NSF Analyzer to Security Controller.

*This version enhances the description of Security Policy Transation and Security Audit System.

Authors' Addresses

Jaehoon Paul Jeong (editor)
Department of Computer Science and Engineering
Sungkyunkwan University
2066 Seobu-Ro, Jangan-Gu
Suwon
Gyeonggi-Do
16419
Republic of Korea

Phone: [+82 31 299 4957](tel:+82312994957)

Email: pauljeong@skku.edu

URI: <http://iotlab.skku.edu/people-jaehoon-jeong.php>

Patrick Lingga
Department of Electronic, Electrical and Computer Engineering
Sungkyunkwan University
2066 Seobu-Ro, Jangan-Gu
Suwon
Gyeonggi-Do
16419
Republic of Korea

Phone: [+82 31 299 4957](tel:+82312994957)

Email: patricklink@skku.edu

Jung-Soo Park
Electronics and Telecommunications Research Institute
218 Gajeong-Ro, Yuseong-Gu
Daejeon
305-700
Republic of Korea

Phone: [+82 42 860 6514](tel:+82428606514)

Email: pjs@etri.re.kr

Diego R. Lopez
Telefonica I+D
Jose Manuel Lara, 9
41013 Seville
Spain

Phone: [+34 682 051 091](tel:+34682051091)

Email: diego.r.lopez@telefonica.com

Susan Hares
Huawei
7453 Hickory Hill
Saline, MI 48176
United States of America

Phone: [+1-734-604-0332](tel:+17346040332)

Email: shares@ndzh.com